

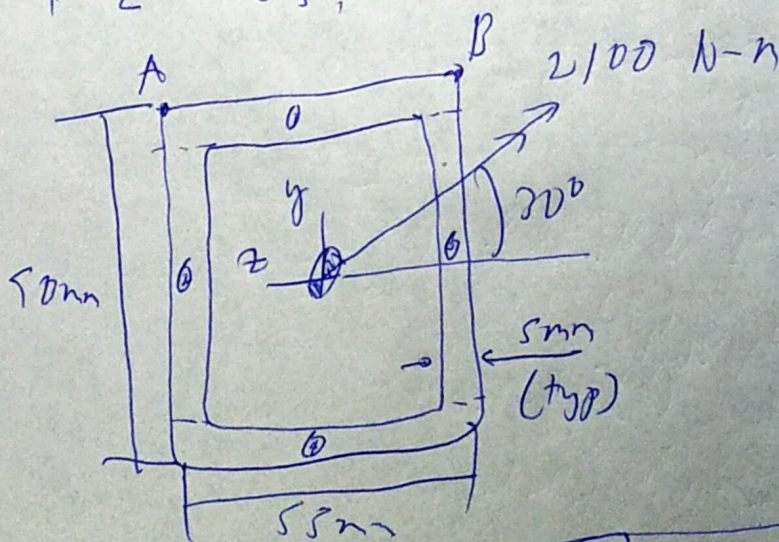
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CEMEX KLQ #2

Unsymmetric Bending (part 2)

1. (Philpot 8.77) A bar with a box cross-section is subjected to a resultant moment of 2100 N-m acting in the xy -plane.

Determine the following:

- 1.1 maximum stress in the beam
1.2 orientation of the neutral axis relative to the $+z$ -axis.



in mm:

part #	$\bar{y}$ of part	$\bar{z}$ of part	h of part	b of part
1	87.5	27.5	5	55
2	45	50	80	5
3	45	2.5	80	5
4	2.5	27.5	5	55

Ans

$$\bar{y} = 45 \text{ mm}$$

$$\bar{z} = 27.5 \text{ mm}$$

$$I_y = 640312.5 \text{ mm}^4$$

$$I_z = 17121250 \text{ mm}^4$$

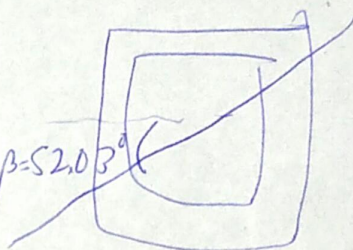
$$I_{yz} = 0 \text{ mm}^4$$

$$M_y = 1.05 \times 10^6 \text{ N-mm}$$

$$M_z = -1.82 \times 10^6 \text{ N-mm}$$

$$\beta = 52.03^\circ$$

$$\beta = -52.03^\circ$$



point	From bottom left		From center		bending stress
	y	z	y	z	
A	90	55	45	27.5	-111.35
B	90	0	45	-27.5	44.86

1.1

$$\text{max tension} = 111.35 \text{ MPa (T)}$$

$$\text{max compression} = 111.35 \text{ MPa (C)}$$

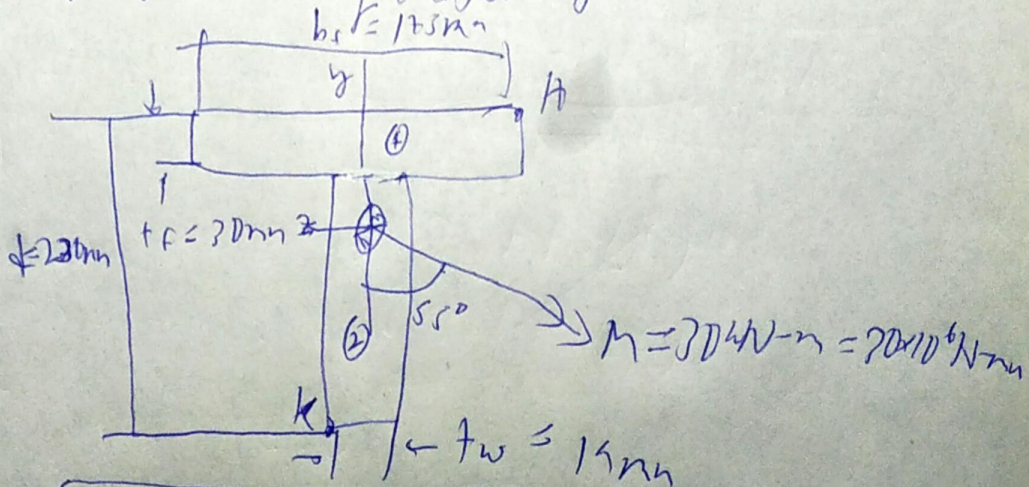
1.2

$$\beta = -52.03^\circ$$

2. (Philpot 8.72) ~~Plot~~ ^{moment} ~~curve~~ ^{curve} on the cross-section of the T-beam has a system of 30 kN-m and is oriented as shown. The cross-sectional dimensions for this beam are $d = 230 \text{ mm}$, $b_f = 175 \text{ mm}$, $t_f = 30 \text{ mm}$ and $t_w = 15 \text{ mm}$.

Required

- 2.1 The bending stress at point A
- 2.2 The bending stress at point K
- 2.3 The orientation of the NA relative to the y -axis



Point	corner geo		point geo on axis	
	y	z	h	b
1	215	87.5	30	175
2	100	87.5	200	15

$$\begin{aligned}
 M_y &= -12.05 \times 10^6 \text{ N-mm} & I_y &= 13.51 \times 10^6 \text{ mm}^4 \\
 M_z &= -12.20 \times 10^6 \text{ N-mm} & I_z &= 42.21 \times 10^6 \text{ mm}^4 \\
 \beta &= 65.43^\circ & P_{yz} &= 0 \text{ mm}^4
 \end{aligned}$$

$$\sigma_x = y_{\text{coeff}} y + z_{\text{coeff}} z$$

$$\sigma_x = - \frac{(M_z I_y + M_y I_{yz}) y}{I_y I_z - I_{yz}^2} + \frac{(M_y I_z + M_z I_{yz}) z}{I_y I_z - I_{yz}^2}$$

$$\tan \beta = \frac{M_y I_z + M_z I_{yz}}{M_z I_y + M_y I_{yz}}$$

	From bottom right		From center		body stress
point	y	z	y	z	σ
H	230	0	63.25	-47.5	103.75 MPa
K	0	97	-16.71	9.5	-76.40 MPa

2.1 $\sigma_H = 103.75 \text{ MPa (T)}$

2.2 $\sigma_K = 76.40 \text{ MPa (C)}$

2.3 $\beta = 65.43^\circ$